5.4.7 Landslide / Mudslides

History

Landslide is the generic term used to describe the downslope movement of earth materials due to gravity. Landslides may be triggered by earthquakes, extreme precipitation, flooding, or otherwise removing support from the slope. There are several different types of landslides that are categorized by the depth of failure, the type of material moved, the water content, and rate of movement (see below). Landslides may also cause flooding, either by displacing great volumes of water with surficial materials, or by damming a stream until it breaches and floods. Each physiographic region in Arizona is susceptible to various types of landslides.

The Colorado Plateau in the northern part of the state typically experiences landslides, debris flows, and rock falls along canyons, buttes, and mesas. These events may be triggered by rain, snow melt, or rain on snow events, and vary tremendously in size. Because this region is sparsely populated, the number of events is underreported. The US Geological Survey (USGS) classifies the Colorado Plateau as one of the four most landslide-prone places in the US (Godt, 1997).

The Transition Zone is the range of mountains that trends SE-NW across the state. Rock falls, landslides, and debris flows occur along the steep mountain slopes, canyons, and along road cuts. Extreme precipitation and snowmelt are the primary triggers here as well; however, flows may occur with less precipitation than usual in areas burned by forest fires. The number of events reported in this region has largely been restricted to those along highways because this region is also sparsely populated, with much of the land belonging to the US Forest Service or various tribes.

The Basin and Range Province occupies the southern portions of Arizona and is characterized by alternating rows of valleys (basins) and mountains (ranges). Debris flows, rock falls, and landslides typically occur in the steep slopes of the ranges; however, the materials can be transported to the valley floors, and are frequently deposited at the base of slopes and at canyon mouths. Debris flows are the most common type experienced, and the area is especially vulnerable to post-fire debris flows. The fastest urban growth areas are along the mountain fronts in areas with past debris flow deposits.

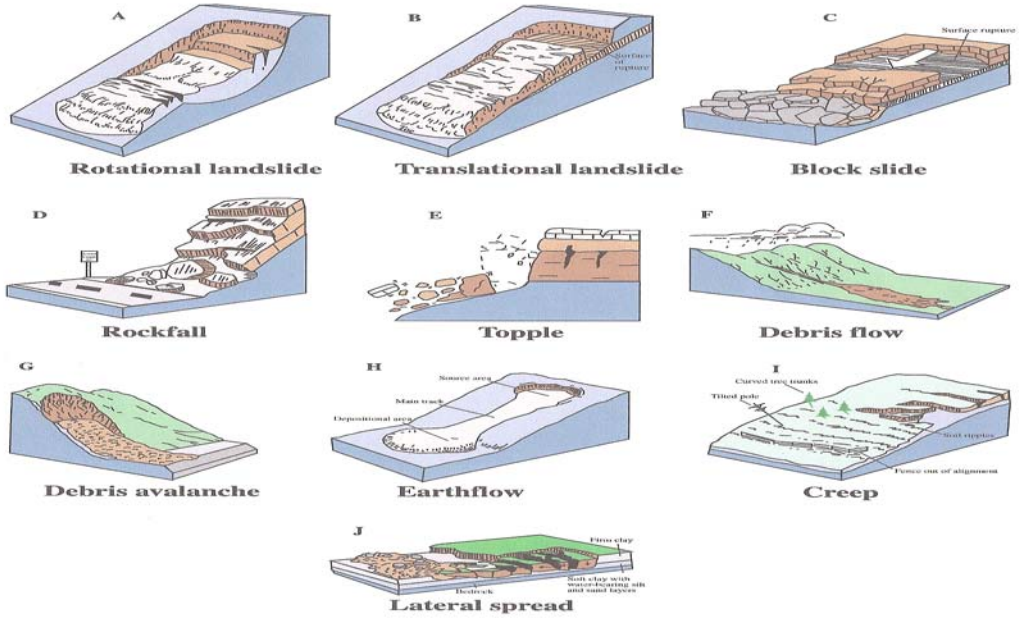


Diagram of the various types of landslides. Diagrams A, B, D, and F are typical of the Colorado Plateau; diagrams D, E, A, B, C, F, and I are typical of the Transition Zone; and diagrams F, D, A, and B are typical of the Basin and Range. (Diagram from USGS Fact Sheet 2004-3072.)

December 1995, a massive landslide blocked the Moenkopi Wash near Tuba City in Coconino County. The landslide deposit created an unstable dam and with the threat of an imminent flash flood impacting downstream communities, a Gubernatorial emergency was declared (ADEM, March 2003; AZ Nat'l Guard, 1997). The town was evacuated until the threat passed and no deaths or injuries were reported. The Grand Canyon is also littered with landslides of various types that occasionally dam the river and collapse, causing flash floods.

March 1978, a landslide occurred on the flank of Camelback Mountain, in Phoenix, that practically destroyed a home (Harris/Pearthree, 2002). During the course of the 2006 Presidentially declared disaster 1660, over 259 debris flow initiation points (with fewer total flows due to coalescing channels in the upper parts of the watersheds) occurred in the Santa Catalina Mountains alone, destroying roads, blocking canyons, and filling one home with sediment. The 1887 earthquake near Bavispe, Sonora, Mexico caused rockfall throughout the state, and catastrophic landslides in the southeastern part of the State (Jenney/Reynolds, 1989).

The only other notable specific landslides identified were the widespread rock falls, rock slides, and avalanches reported throughout Arizona due to the 1887 earthquake in Sonora, Mexico. Huge blocks of rock are reported to have fallen throughout the State and the southeastern part of the State was severely affected by various forms of catastrophic down slope movement (Jenney & Reynolds, 1989).

Landslides in Arizona caused nearly $1 million in damage between 1980 and 1985 (in 1985 dollars), with the majority of the reporting coming from the Arizona Department of Transportation (Realmuto, 1985). However, a few large slides occurred on USFS land in Coconino County during that same time frame. Landslide risk is increasing as the population expands into previously uninhabited areas that are prone to slope failure.

Map 27

Updated map with data from original Plan map as no data from 1985-Present that could be obtained.

Probability and Magnitude

Most of the State is susceptible to landsliding. Precipitation of high intensity or long duration may cause a previously stable slope to move. Even precipitation of medium intensity and short duration may cause instability in areas that have been severely burned by forest fires. Removal of support from the slopes where highways and roads are emplaced will continue to cause the landslides, as will development up the mountainsides. Earthquakes may also cause landslides.

The landslides range in size and frequency, from small, nuisance events (minor shallow landslides, rockfalls) along roads or uninhabited areas, to large, fast-moving, destructive debris flows (commonly referred to as mudslides), with varying effects depending on location.

In an attempt to categorize the probability of future landslide/mudslide events, the hazard was analyzed using the CPRI. This method also takes into account the levels of magnitude/severity, warning time and duration. In Arizona, landslide/mudslides possible, the magnitude/severity is typically limited, the warning time is less than 6 hours and the duration is usually less than 6 hours. These factors resulted in a CPRI rating of 2.2. The highest rating a hazard can result in using this method is 4.

Vulnerability

The impacts from landslides can cause deaths and damages without warning, throughout many parts of Arizona. In the United States some of the economic factors that result from landslides include:

- Cost $3.5 billion a year in damages.
- Causes between 25 and 50 deaths annually.
- Reduction in real estate values and tourist revenue
- Lead to lost human, industrial, agricultural, and forest productivity
- Cause damage to the natural environment (USGS, 2005).

In 1995, the Moenkopi Landslide in Coconino County occurred causing $7,762 in damages.

Local risk assessment summary, the table below combines asset and predominantly HAZUS information for the estimated losses as reflected in local plans. The potential total number of facilities in the landslide/mudslide areas is four with an unknown replacement cost and the losses are not estimated.

Summary of Local Risk Assessment & Loss Estimates based on Landslide/Mudslide			
	Total Assets $ (Assets +HAZUS) x $1,000	# of Facilities Impacted (Assets + HAZUS)	Estimated Loss
Statewide Totals	-----	4	-----
Mohave	-----	4	N/A
----- Denotes lack of available information for assessment.			

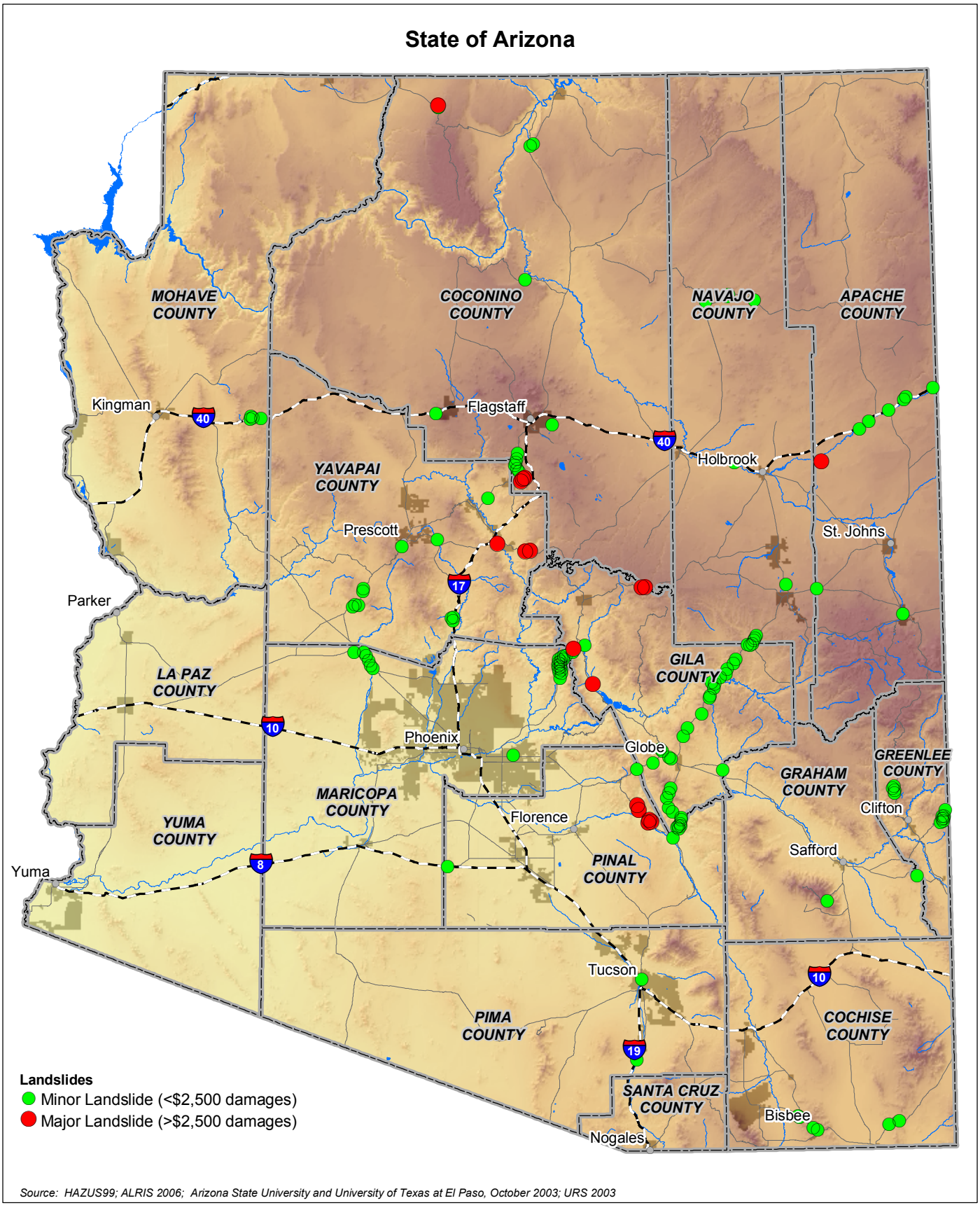
Sources:

Godt, J.W., 1997, *Digital compilation of landslide overview map of the conterminous united states, 1982*. USGS, OFR 97-289.

Harris, R.C., & Pearthree, P.A., 2002, *A home buyer's guide to geologic hazards in Arizona*. AZGS, Down-to-Earth 13.

Realmuto, V.J., 1985, *Preliminary map of selected mass movement events in Arizona*. AZGS, OFR 85-16.

The Jenney & Reynolds, 1989 and the ADEM, March 6, 2003; Arizona National Guard, 1997 references are from the previous version of the Plan.



Source: HAZUS99; ALRIS 2006; Arizona State University and University of Texas at El Paso, October 2003; URS 2003

Legend

- Major City
- interstate
- Highway
- Major Streams
- County
- Lakes
- Cities

N

0 25 50

Miles

August 2007

State of Arizona Multi-Hazard Mitigation Plan

Map 27
Landslides by Damages
1975 thru Present

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